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In re Patent Application of:
Woong S. Choi

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Art Unit: 2871

For: REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE HAVING A HIGH APERATURE RATIO

Examiner: Z. Q. Qi

SUBMISSION OF CERTIFIED TRANSLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Attached is a certified translation of Korean Patent Application No. 1998-51185. This verified translation is submitted in order to perfect the priority claim in the present patent application and to remove U.S. Patent No. 5,953,088 as prior art under 35 U.S.C. § 102(e).

Dated: April 8, 2004

Respectfully submitted,

By Eric J. Nuss

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VERIFICATION OF TRANSLATION

I, Chan-Joo YOUN of 901 Seoyoung Bldg., 158-12, Samsung-dong, Kangnam-ku, Seoul, 135-090, Korea, declare that I have a thorough knowledge of the Korean and English languages, and the writings contained in the following pages are correct English translation of the specification and claims of Korean Patent Application No. 1998-51185.

This 24^{th} day of March, 2004

By:

[Chan-Joo YOUN]

KOREAN INDUSTRIAL

PROPERTY OFFICE

This is to certify that the following application annexed hereto

is a true copy from the records of the Korean Intellectual Property Office

Application Number **: 1998 year Patent Application 51185, PATENT-1998-0051185**

Date of Application **: November 27, 1998**

Applicant(s) **: LG. Philips LCD Co., Ltd.**

2003 year 03 month 19 date

COMMISSIONER

[BIBLIOGRPHICAL DOCUMENTS]

[TITLE OF DOCUMENT] PATENT APPLICATION

[RECIPIENT] COMMISSIONER

[NUMBER OF DOCUMENT] 1

[SUBMISSION DATE] 11. 27. 1998

[TITLE OF INVENTION IN KOREAN] 반사형 액정 표시장치 및 그 제조방법

[TITLE OF INVENTION IN ENGLISH] REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FABRICATING THE SAME

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[PURPORT] We submit application as above under the article 42 of the Patent Law.

Attorney Jung, Won-Ki (seal)

Attorney Lee, Chan-Hoon (seal)

[FEES]

[BASIC APPLICATION FEE]	20 pages	29,000	won
[ADDITIONAL APPLICATION FEE]	3 pages	3,000	won
[PRIORITY FEE]	0 things	0	won

[EXAMINATION REQUEST FEE]	0 clamis	0	Won
[TOTAL]		32,000	Won

[ENCLOSED]

1. Abstract, Specifications (with Drawings)_1 set
2. FD including Copy of Applicaton, Abstract, Specification (with Drawings)_1 set
3. Power of Attorney (with Translation thereof)

[DOCUMENT OF ABSTRACT]

[ABSTRACT]

An object of the present invention is to provide a liquid crystal display device having an improved display quality and an improved aperture ratio.

A reflective

[REPRESENTATIVE FIGURE]

FIG. 3

[SPECIFICATIONS]

[NAME OF INVENTION]

Reflection Type Liquid Crystal Display Device And Method Of Fabricating The Same

[BRIEF EXPLANATION OF FIGURES]

FIG. 1 is a plan view showing one pixel region of a reflection type thin film transistor liquid crystal display (TFT-LCD) device having high aperture ratio according to the prior art;

FIGs. 2A to 2E are cross-sectional views, which are taken along a line II-II' of FIG. 1, showing a process of fabricating the display device according to the prior art;

FIG. 3 is a plan view showing one pixel region of a reflection type thin film transistor liquid crystal display (TFT-LCD) according to an embodiment of the present invention; and

FIG. 4A to 4E are cross-sectional views, which are taken along a line IV-IV' of FIG. 3, showing a process of fabricating the display device according to an embodiment of the present invention.

* Explanation of major parts in the figures *

1: substrate
50: data line
52: adjacent data line
54: adjacent gate line
56: gate line
58: gate electrode
60: source electrode
62: drain electrode
64: reflective electrode
70: first insulating layer
72: semiconductor layer
74: second insulating layer

76: contact hole

[DETAILED DESCRIPTION OF INVENTION]

[OBJECT OF INVENTION]

[TECHNICAL FIELD OF THE INVENTION AND PRIOR ART OF THE FIELD]

The present invention relates to a liquid crystal display (LCD) device, and more particularly to a reflection type liquid crystal display device having a high aperture ratio.

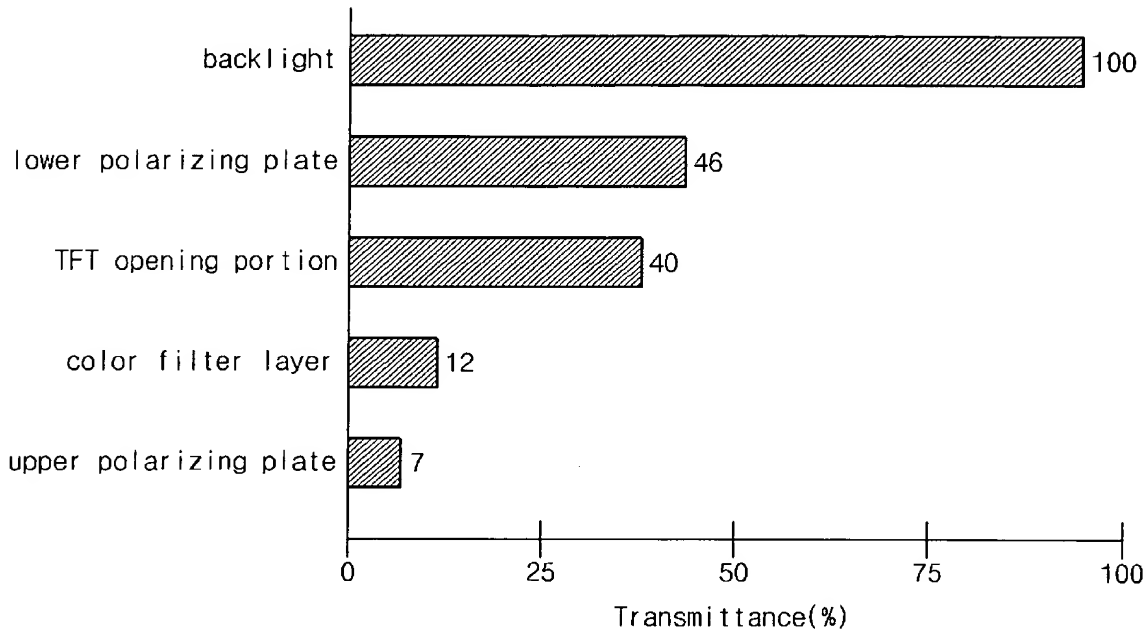
Display devices treating a large amount of information have been subject of recent researches in the coming of the information age.

Cathode ray tube (CRT) devices have been commonly used for display devices. Recently, however, flat panel display (FPD) devices having excellent operational characteristics, such as light weight and low power consumption are being developed. Accordingly, thin film transistor liquid crystal display (TFT-LCD) devices having are developed because of their high color reproducibility and thin profile.

Regarding function of the TFT-LCD device, when a pixel is switched by a TFT, the pixel transmits light from a light source under the TFT-LCD. An amorphous silicon TFT (a-Si:H TFT), where a semiconductor layer is formed of amorphous silicon, is widely used as a switching element. An amorphous silicon thin film may be formed on a large-sized insulating substrate such as a glass under a low temperature.

In general, a TFT-LCD device displays images using light of a light source such as a backlight under a liquid crystal panel. However, a TFT-LCD is an ineffective optical modulator where only about 3% to about 8% of incident light from a backlight passes through the liquid crystal panel.

When transmittance of two polarizing plates is about 45%, transmittance of two substrates is about 94%, transmittance of TFT array and pixel is about 65%, and transmittance of color filter layer is about 27%, transmittance of a TFT-LCD device is about 7.4%. TABLE 1 shows accumulated transmittances of light from a backlight at respective layer.



Since only about 7% of light from the backlight is emitted through a TFT-LCD device, the backlight should emit light of a relatively high brightness. Accordingly, power consumption of the backlight increases. As a result, a large capacity heavy battery is commonly used to supply sufficient power for the backlight. Moreover, use of the large capacity battery limits operating time.

To solve the above problems, a reflection type TFT-LCD device without a backlight has been researched. Operating time of the reflection type TFT-LCD device increases because power consumption greatly decreases due to use of ambient light as a light source. Moreover, aperture ratio of the reflection type TFT-LCD device is improved.

Referring to drawings, a reflection type TFT-LCD device will be illustrated.

A TFT-LCD device includes an upper substrate referred to as a color filter substrate, a lower substrate referred to as a TFT array substrate and a backlight outside the lower substrate. Following illustrations relate to a lower substrate, i.e., a TFT array substrate.

FIG. 1 is a plan view showing one pixel region of a reflection type TFT-LCD device according to the conventional art. An nth gate line 8 and an (n-1)th gate line 6 are transversely disposed on a substrate. An nth data line 2 and an (n+1)the data line 4 are disposed longitudinally on the substrate and cross the gate line 8 and the (n-1)th gate line 6 to constitute matrix. A gate electrode 18 is disposed at a specific portion of the nth gate line 8 and a source electrode 12 connected to the nth data line is disposed to overlap the gate electrode 18. Moreover, a drain electrode 14 is formed to correspond the source electrode 12 and a reflective electrode 10 electrically contacts the drain electrode 14 through a contact hole over the drain electrode 14.

FIGs. 2A to 2D are cross-sectional views, which are taken along a line II - II' of FIG. 1, showing a process of fabricating the display device according to the prior art.

In FIG. 2A, a gate electrode 12 is formed by depositing and patterning a first metal, i.e., a gate metal. The first metal for the gate electrode 12 is deposited using a sputter and is formed of one of chromium (Cr), molybdenum (Mo), aluminum (Al), titanium (Ti), tin (Sn), tungsten (W) and copper (Cu).

In FIG. 2B, after depositing an insulating layer 30 on the gate electrode 12, an island 32 of TFT is formed by sequentially depositing and patterning a semiconductor layer. The island functions as an active layer of TFT. The insulating layer 30 may include one of an inorganic material such as silicon nitride and silicon oxide and an organic material such as benzocyclobutene (BCB).

In FIG. 2C, a data line, a source electrode and a drain electrode used for TFT are formed through a method similar to that for the fate electrode 12. The source electrode 12, the drain electrode 14, an (n+1)th data line 4 and an nth data line 2 are formed by depositing and patterning a second metal. Even though not shown in FIG. 2C, the nth data line 2 is electrically connected to the source electrode 12.

In FIG. 2D, a passivation layer 34 is formed to protect the lines and electrodes. In addition, the passivation layer 34 separates a subsequent electrode as an interlayer insulating layer. The passivation layer 34 has a contact hole 16 corresponding to the drain electrode 14.

In FIG. 2E, a light-shielding layer (not shown) and a reflective electrode 10 are formed. The light-shielding layer prevents light from entering the island 32 of TFT.

Since the reflection type TFT-LCD device does not use a backlight therein, the reflection type TFT-LCD device may be operated for a long time period. Ambient natural light reflects from the reflective electrode 10 and the reflection type TFT-LCD uses light reflecting from the reflective electrode 10.

In order to increase the aperture ratio of the conventional reflection type TFT-LCD device, the reflective electrode 10 extends to overlap the data lines 2 and 4. As shown in FIGs. 1 and 2E, the reflective electrode 10 overlaps the nth data line 2 and the (n+1)th data line 4 by an overlapped length "ΔL". Accordingly, the aperture ratio of the device increases by the overlapped length "ΔL".

[TECHNICAL SUBJECT OF INVENTION]

However, since the reflective electrode 10 and the adjacent pixel electrodes 10a and 10b overlap the data lines 2 and 4, respectively, the overlapped length "ΔL" is limited taking account into misalign margin "A".

Furthermore, if a misalign happens during the fabrication process, the overlapped length "ΔL" of the reflective electrode 10 and the nth data line 2 may be different from the overlapped length "ΔL" of the reflective electrode 10 and the (n+1)th data line 4. Accordingly, parasitic capacitance of the reflective electrode 10 and the nth data line 2 may be different from parasitic capacitance of the reflective electrode 10 and the (n+1)th data line 4. This difference may cause a vertical cross-talk influencing a display quality of the TFT-LCD device. The cross-talk is a kind of noise in the TFT-LCD where an address line not selected by an external driving circuit functions as a capacitor due to the parasitic capacitance resulting from the difference of the overlapped length "ΔL". Therefore, a display quality of the TFT-LCD device is degraded.

Moreover, since the process of fabricating the conventional reflection type TFT-LCD includes a misalign margin "A", the aperture ratio decreases by the misalign margin "A".

An object of the present invention is to provide a reflection type TFT-LCD device having a high aperture ratio.

Another object of the present invention is to provide a reflection type TFT-LCD device which can minimize reflection by data lines.

Another object of the present invention is to provide a reflection type TFT-LCD device which can minimize cross-talk.

Another object of the present invention is to provide a reflection type TFT-LCD device which is fabricated through a reduced process steps.

[CONSTRUCTION AND OPERATION OF INVENTION]

To achieve these and other objects and in accordance with the purpose of the present invention, as embodied and broadly described, the present invention discloses a reflection

type liquid crystal display device including: a substrate; a gate line along a first direction on the substrate, the gate line having a gate electrode; a semiconductor layer overlapping and insulated from the gate electrode; a data line crossing the first direction on the substrate, the data line being insulated from the gate line and substantially perpendicular to the gate line; a thin film transistor on the substrate, the thin film transistor including a source electrode connected to the data line and a drain electrode corresponding to the source electrode; a reflective electrode covering portions of the adjacent data lines, the portions substantially having the same area as each other, the reflective electrode overlapping the gate line and contacting the drain electrode; and a storage capacitor including the overlapped gate line as a first storage electrode and the overlapped reflective electrode as a second storage electrode.

In another aspect, the present invention discloses a method of fabricating a reflection type liquid crystal display device including: depositing a first conductive layer on a substrate; patterning the first conductive layer to form a gate line and a gate electrode; forming a first insulating layer on the gate electrode and the gate line; forming a semiconductor layer including amorphous silicon and impurity-doped amorphous silicon on the first insulating layer; patterning the semiconductor layer to form an active layer on the first insulating layer over the gate electrode; forming a second conductive layer on an entire surface of the substrate having the active layer; patterning the second conductive layer to form a data line perpendicular to the gate line, a source electrode connected to the data line and overlapping the gate electrode, and a drain electrode facing the source electrode and overlapping the gate electrode; forming a second insulating layer on the second conductive layer and patterning the second insulating layer to form a contact hole over the drain electrode; and forming a third conductive layer on the second insulating layer and pattering the third conductive layer to

form a pixel electrode covering the adjacent data lines, the covered portions of the adjacent data lines substantially having the same area as each other.

Hereinafter, reference will now be made in detail to the embodiment of the present invention, example of which is illustrated in the accompanying drawings.

FIG. 3 is a plan view showing one pixel region of a reflection type thin film transistor liquid crystal display (TFT-LCD) according to an embodiment of the present invention and FIG. 4A to 4E are cross-sectional views, which are taken along a line IV-IV' of FIG. 3, showing a process of fabricating the display device according to an embodiment of the present invention.

In FIG. 3, an nth gate line 56 and an (n+1) gate line 54 are disposed along a row direction. In addition, an nth data line 50 and an (n+1) data line 52 are disposed along a column direction. A source electrode 60, a drain electrode 62 and a gate electrode 58 constitute a thin film transistor.

Further, a reflective electrode 64 is formed in a pixel region of the TFT-LCD device.

To reduce a vertical cross-talk of the TFT-LCD device and utilize a portion excluded from an opening portion of a conventional TFT-LCD device as a pixel region, the reflective electrode 64 overlaps the nth data line 50 and the (n+1)th data line 52 to constitute overlapped regions "B" and "B'", respectively. The cross-talk is a phenomenon such that a display quality is degraded because a liquid crystal layer is influenced by an electric field of the data lines 50 and 52 when a voltage is applied to the data lines 50 and 52.

In order to reduce drawbacks such as a cross-talk and a flicker, the TFT-LCD may be driven by several method. In general, the TFT-LCD device may be driven by an AC

(alternative current) driving method to prevent deterioration of a liquid crystal layer. In the AC driving method, a (+) polarity signal and a (-) polarity signal are alternately applied to one pixel through the data line. For example, the TFT-LCD device may be driven by a field inversion method, a gate inversion method, a data inversion method or a dot inversion method.

In other words, when signals are applied to the nth data line 50 and the (n+1) data line 52 in an AC driving method, electric fields having opposite polarities are generated near the nth data line 50 and the (n+1) data line, respectively. Since the overlapped regions “B” and “B’” have the same area as each other, the electric fields having opposite polarities are offset by each other. Accordingly, the signals applied to the reflective electrode 64 are not influenced, thereby aperture ratio and display quality improved.

In FIG. 4A, a gate electrode 58 is formed on a substrate 1 by depositing and patterning a first conductive material, which is a first step of fabricating an array substrate for a TFT-LCD device.

In FIG. 4B, after depositing a first insulating layer 70 on the substrate 1 having the gate electrode 58, an active layer 72 is formed by depositing and patterning a semiconductor layer. The active layer 72 includes amorphous silicon and impurity-doped amorphous silicon

In FIG. 4C, a data line 50 and 52, a source electrode 60 and a drain electrode 62 are formed by depositing and patterning a second conductive material. The source electrode 60 and the drain electrode 62 overlap the active layer 72 and the gate electrode 58.

In FIG. 4D, a second insulating layer 74 is formed on an entire surface of the substrate as an interlayer insulating layer. Subsequently, the second insulating layer is etched to have a contact hole 76 over the drain electrode 62.

In FIG. 4E, a pixel electrode 64 is formed by depositing and patterning a third conductive material. The pixel electrode 64 connected to the drain electrode 62 through the contact hole 76 functions as a reflective plate of the reflection type TFT-LCD device.

In a reflection type TFT-LCD device according to the present invention, since parasitic capacitances of the overlapped regions "B" and "B'" of the reflective electrode 64 with the nth data line 50 and the (n+1)th data line 52 have opposite polarities due to an inversion driving method, two parasitic capacitances are offset by each other. Further, since the reflective electrode 64 covers the data lines, reflection from the data lines 50 and 52 may be reduced and an additional black matrix (BM) is not necessary. Accordingly, aperture ratio is improved and vertical cross-talk is reduced.

When the overlapped regions "B" and "B'" of the reflective electrode 64 with the nth data line 50 and the (n+1)th data line 52 have substantially the same area as each other, the offset effect may increase.

[EFFECT OF INVENTION]

A reflection type TFT-LCD according to the present invention has several advantages.

First, since overlapped regions of a reflective electrode with adjacent data lines have similar areas to each other in an inversion driving method where signals having opposite polarities are applied to the adjacent data lines, vertical cross-talks are offset by each other and stable images are displayed.

Second, since a reflective electrode functioning as a pixel electrode extends to adjacent data lines, aperture ratio is improved.

Third, since a reflective electrode covers adjacent data lines and shields incident light, a black matrix (BM) may be omitted.

Fourth, since aperture ratio increases, brightness also increases.

[RANGE OF CLAIMS]

[CLAIM 1]

A reflection type liquid crystal display device, comprising:

a substrate;

a gate line along a first direction on the substrate, the gate line having a gate electrode;

a semiconductor layer overlapping and insulated from the gate electrode;

a data line crossing the first direction on the substrate, the data line being insulated from the gate line and substantially perpendicular to the gate line;

a thin film transistor on the substrate, the thin film transistor including a source electrode connected to the data line and a drain electrode corresponding to the source electrode;

a reflective electrode covering portions of the adjacent data lines, the portions substantially having the same area as each other, the reflective electrode overlapping the gate line and contacting the drain electrode; and

a storage capacitor including the overlapped gate line as a first storage electrode and the overlapped reflective electrode as a second storage electrode.

[CLAIM 2]

The reflection type liquid crystal display device according to claim 1, wherein the reflectvie electrode covers a full width of the adjacent data lines and a half length of the adjacent data lines.

[CLAIM 3]

The reflection type liquid crystal display device according to claim 1, wherein the semiconductor layer includes amorphous silicon and impurity-doped amorphous silicon.

[CLAIM 4]

The reflection type liquid crystal display device according to claim 1, wherein the gate electrode, the gate line, the data line, the source electrode, the drain electrode and the reflective electrode substantially include an opaque metal.

[CLAIM 5]

A method of fabricating a reflection type liquid crystal display device, comprising:

depositing a first conductive layer on a substrate;

patterning the first conductive layer to form a gate line and a gate electrode;

forming a first insulating layer on the gate electrode and the gate line;

forming a semiconductor layer including amorphous silicon and impurity-doped amorphous silicon on the first insulating layer;

patterning the semiconductor layer to form an active layer on the first insulating layer over the gate electrode;

forming a second conductive layer on an entire surface of the substrate having the active layer;

patterning the second conductive layer to form a data line perpendicular to the gate line, a source electrode connected to the data line and overlapping the gate

electrode, and a drain electrode facing the source electrode and overlapping the gate electrode;

forming a second insulating layer on the second conductive layer and patterning the second insulating layer to form a contact hole over the drain electrode; and

forming a third conductive layer on the second insulating layer and pattering the third conductive layer to form a pixel electrode covering the adjacent data lines, the covered portions of the adjacent data lines substantially having the same area as each other.

[CLAIM 6]

The method of fabricating a reflection type liquid crystal display device according to claim 5, wherein the pixel electrode covers a full width of the adjacent data lines and a half length of the adjacent data lines.

[CLAIM 7]

The method of fabricating a reflection type liquid crystal display device according to claim 6, wherein the oerlapped portion of the adjacent data lines have capacitances of same values and opposite polarities.

[CLAIM 8]

The method of fabricating a reflection type liquid crystal display device according to claim 5, wherein the pixel electrode is a reflective electrode reflecting an external light.

[CLAIM 9]

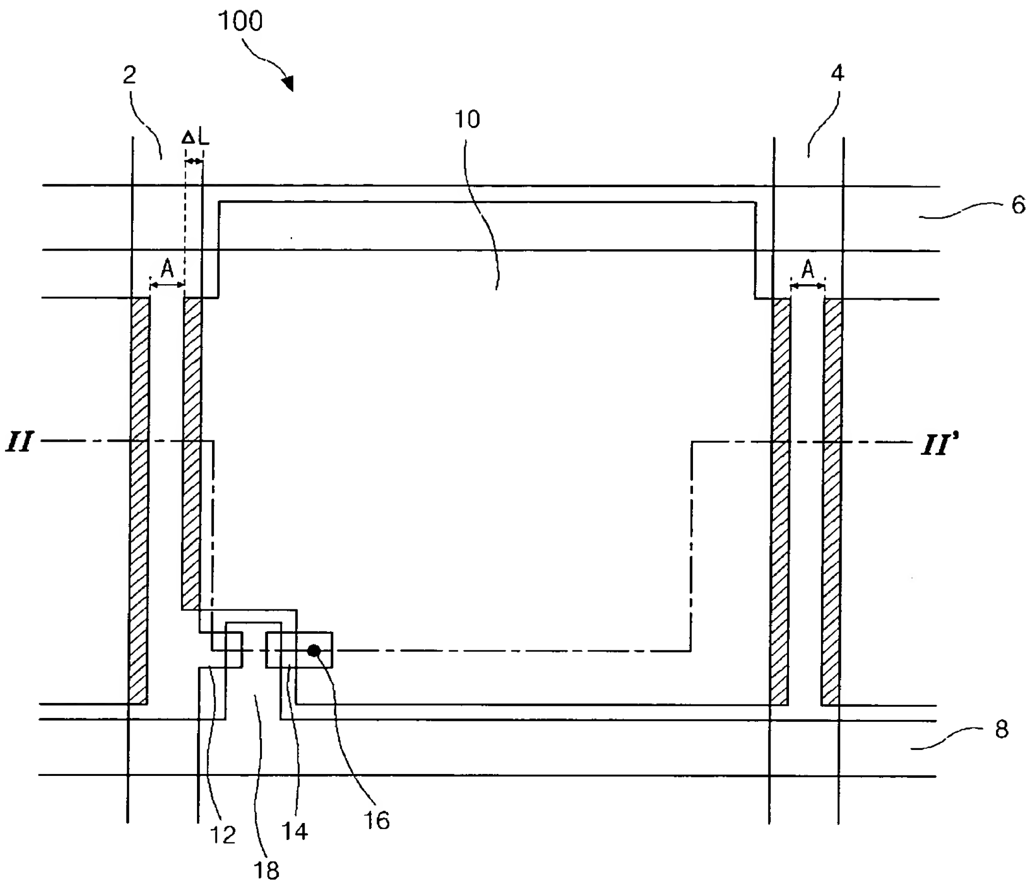
The method of fabricating a reflection type liquid crystal display device according to claim 5, wherein the first conductive layer, the second conductive layer and the third conductive layer substantially include an opaque metal.

[CLAIM 10]

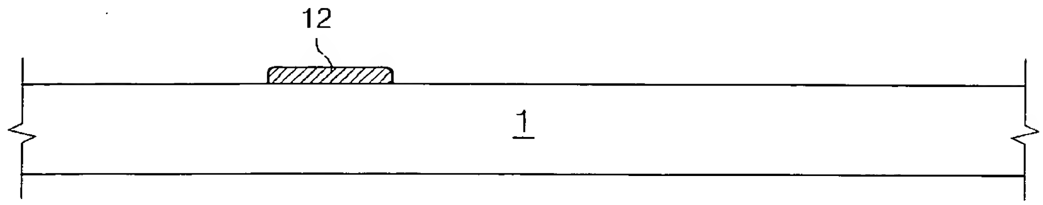
The method of fabricating a reflection type liquid crystal display device according to claim 5, wherein the second insulating layer includes an organic material.

[DRAWINGS]

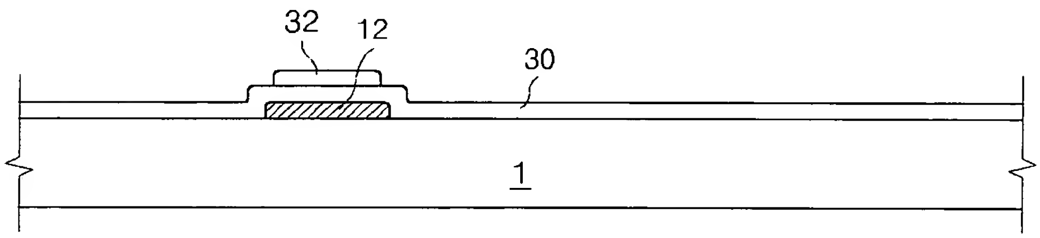
[FIG. 1]



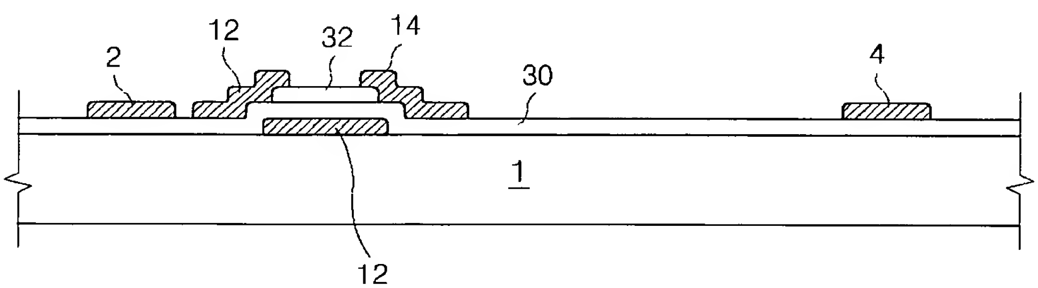
[FIG. 2A]



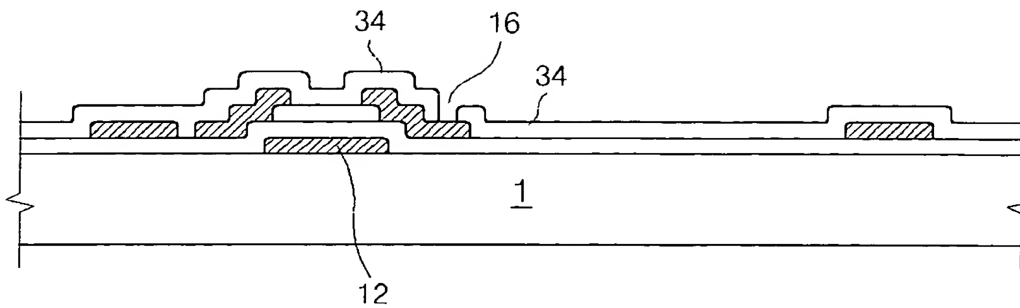
[FIG. 2B]



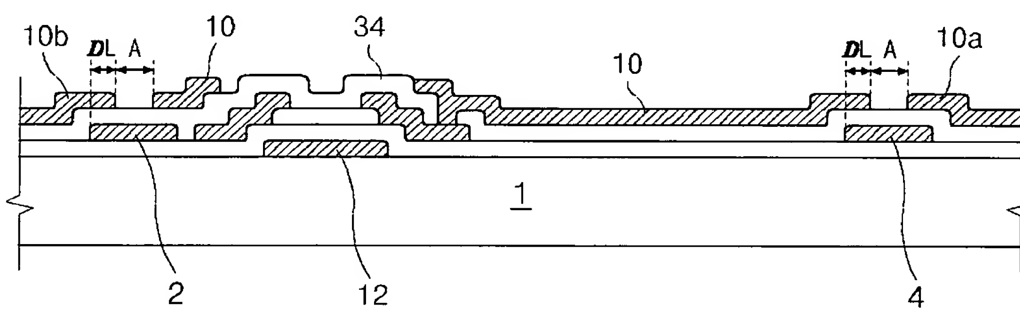
[FIG. 2C]



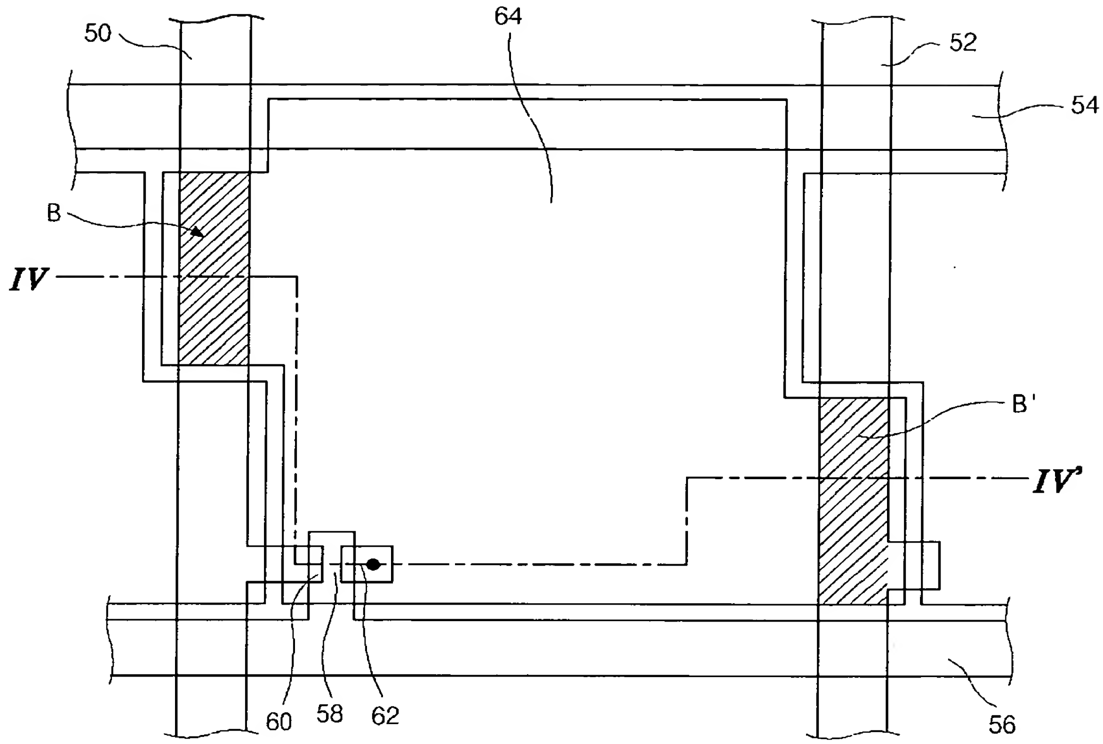
[FIG. 2D]



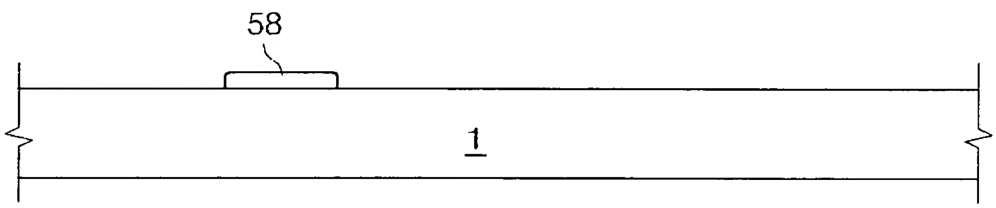
[FIG. 2E]



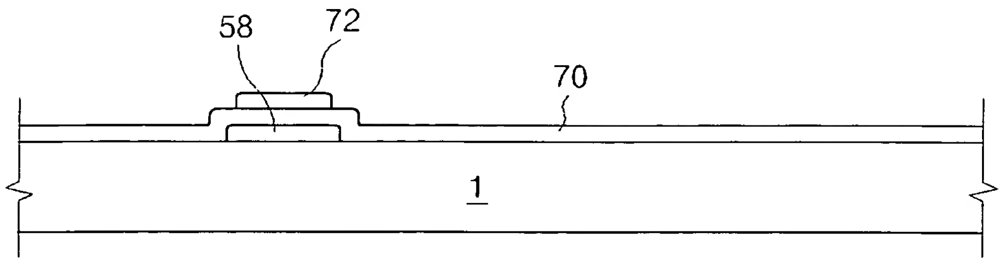
[FIG. 3]



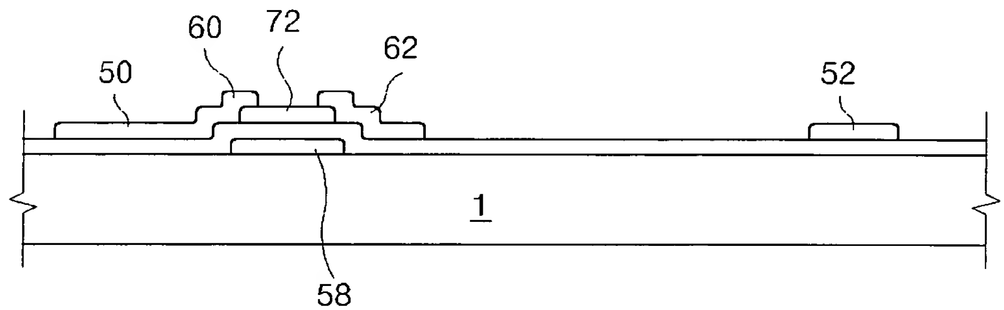
[FIG. 4A]



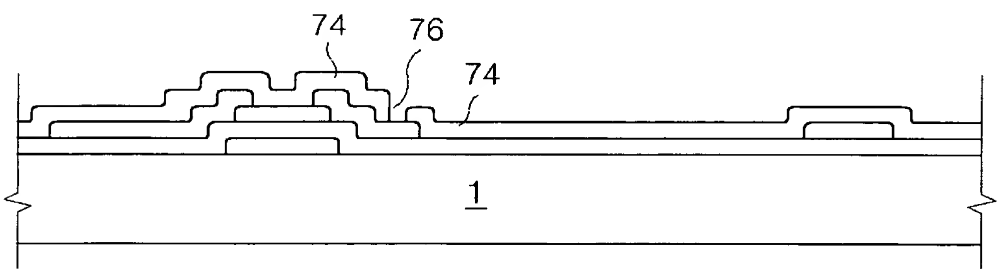
[FIG. 4B]



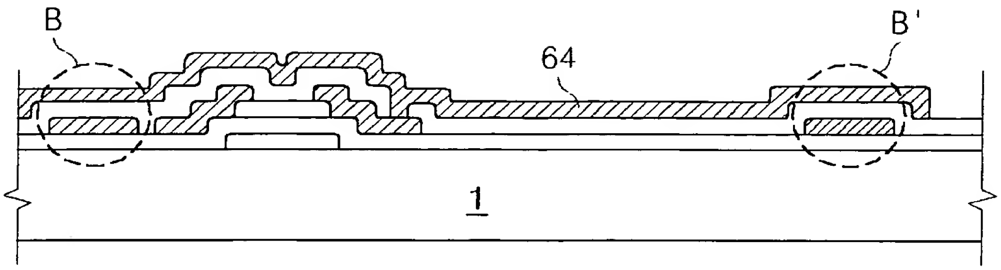
[FIG. 4C]



[FIG. 4D]



[FIG. 4E]



B
B'
64
1